



Environmental Considerations for Cultural Heritage Materials

Indiana SHRAB 2010

Katie Mullen

We'll examine

- Effects of temperature, RH and light
- on collections materials
- How scientists have built a framework to predict damage from environmental factors
- How that framework can help you make decisions about your collection
- Recommended guidelines and what they mean in a real setting
- How to measure conditions, and understanding what you're measuring

We'll examine, cont.

- Using HVAC to control the environment
- Preservation tools to control the environment in an exhibit
- How to make improvements – small and big
- Sources of funding
- Sources of further information
- The future: passive climate control

Effects of Temperature and Relative Humidity on Collections

- Mechanical
- Chemical
- Biological

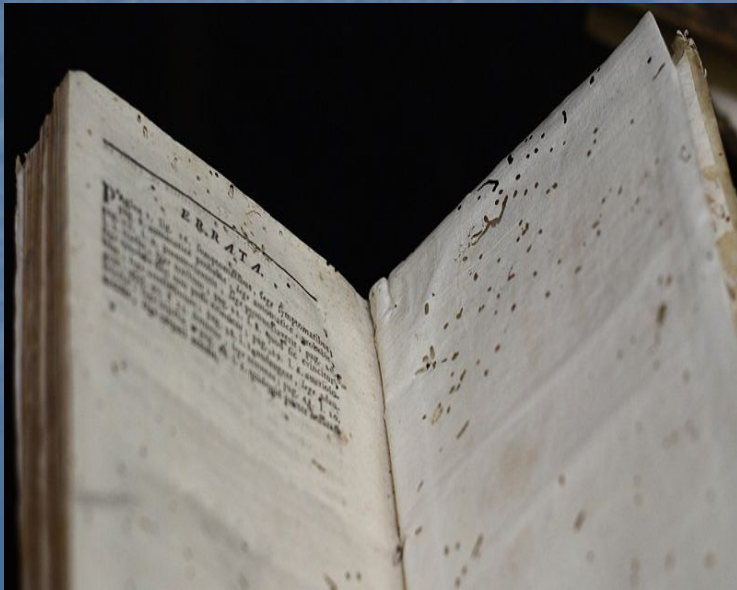
Hygroscopic Materials

- Many organic materials want to be in equilibrium with their surrounding environment. (textiles, paper, skins, wooden artifacts etc.)
- They adsorb and desorb water vapor and pollutants to achieve this equilibrium

Biological



Mold = too much water in your environment, either as vapor or liquid



Pests are inclined to feast on materials that hold a high moisture content.

Mechanical Damage



Hygroscopic materials flex from sorption of moisture

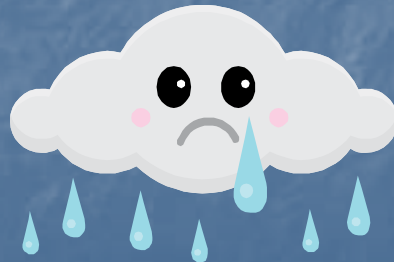
Chemical



A buildup of energy is required to activate a chemical reaction, and Heat = Energy

Chemical reactions run faster at higher temperature

Excess Moisture facilitates reactions that are part of the degradation of cultural heritage materials.



Too *little* moisture, on the other hand, will embrittle cellulosic materials

Chemical Effects of High Moisture Content

- Studies have shown that certain pollutants in the atmosphere and the inclusion of metal particulates in paper – often a byproduct of modern manufacturing – are only damaging to the paper if there is sufficiently high moisture content

Pollack, H. 1961. "Dehumidification for the preservation of documents, [part 1]." *Mechanical World*. August, 268.

Chemical effects of high humidity

- Law of the mass of action

For us, this means that rate of decay involving water as a reactant are proportional to the amount of water available to react.

Chemical Effects of High Temperature

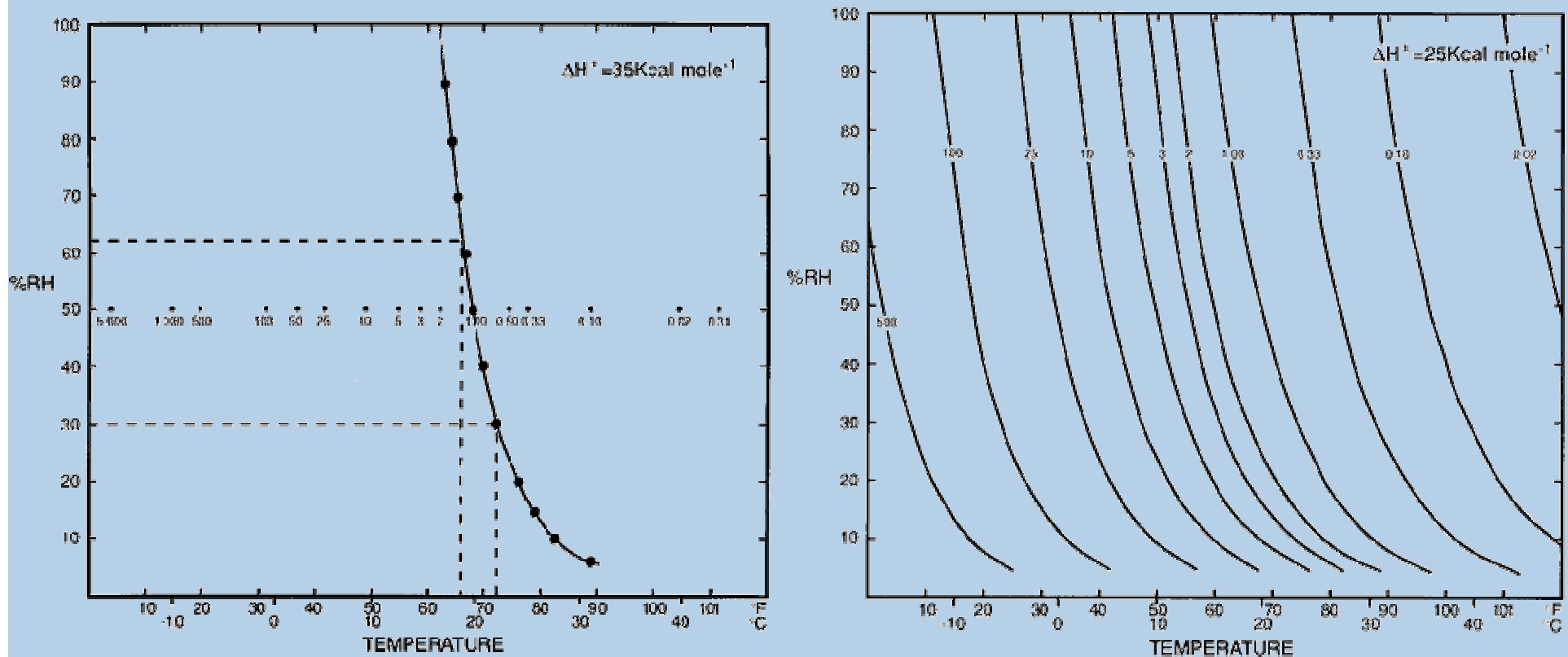
- Arrhenius equation

$$k = Ae^{-E_a/RT}$$

- exponential dependence of a reaction rate on temperature
- Activation energy
- Used in accelerated aging tests to make determinations about the lifespan of materials

Application of Accelerated Aging to Cultural Heritage Materials

Isoperms



From "Isoperms: and environmental management tool" <http://www.clir.org/pubs/reports/isoperm/isoperm.html>, Donald K. Sebera
CLIR 1994

Isoperms as translated into collections management tools (sort of)

The screenshot shows a software window titled "Preservation Calculator" with a menu bar (File, Print, Tools, Help). The interface is divided into several sections:

- Temp °F:** A text box containing "68" with a red background, and a label "ROOM" below it. Below this is a vertical slider with a red track and a white knob.
- % RH:** A text box containing "45" with a blue background, and a label "MODERATE" below it. Below this is a vertical slider with a blue track and a white knob.
- Preservation Index (PI):** A text box containing "50" and the word "Years" to its right.
- Natural Aging Rate:** A text box containing "MODERATE".
- Days to Mold Germination:** A text box containing "No Risk" in green text.
- Exit:** A button in the bottom right corner.
- Footer:** A bar at the bottom containing a temperature unit selector ("°F/°C"), the instruction "Use arrow keys or mouse to move sliders", and a link "Visit the IPI Web Site".

The Image Permanence Institute Preservation Calculator

Wait!

Preservation Calculator

File Print Tools Help

Temp °F 68 ROOM

% RH 45 MODERATE

Preservation Index (PI) 50 Years

Natural Aging Rate MODERATE

Days to Mold Germination No Risk

Exit

°F/°C Use arrow keys or mouse to move sliders Visit the IPI Web Site

You say that if I store my collection at 68 degrees Fahrenheit and 45% RH – well within established guidelines - it will only last 50 years?

Pros and Cons

- Con: The numbers often aren't "real"
 - Take into account only degradation from one or two chemical means, and not biological or handling
 - Math assumes one chemical rxn at a time...
- Pro: These are tools for providing relative values of the effect of climate conditions on collections materials.
- Pro: They aid you in making decisions about your collections storage areas and conditions
- Pro: They can help you make the case to administration or a granting institution for aid in bettering climate conditions for your collections.

Light

- Light = energy

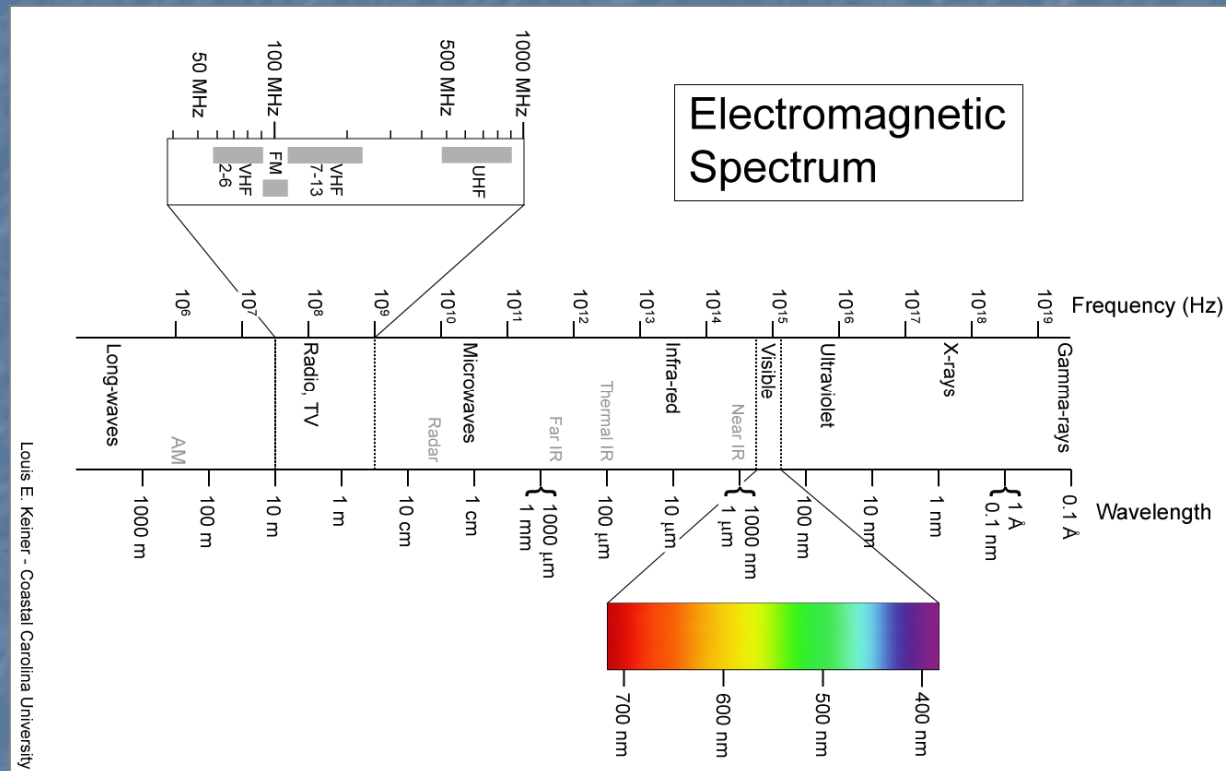


Image from Wikimedia Commons

Light, cont

- All light is damaging, and the damage is cumulative
- Can't really be quantified, even to the relative degree that the effects of temperature and humidity can, though there is a standard measure in use in conservation – the blue wool card
- Filter out as much as you can, without affecting the visual quality of the work

How do you control light exposure?

- Keep blinds drawn in areas where there are collections materials
- Use UV filtering materials over windows and fluorescent lights – or conversely, on exhibit cases/glazing in frames. (note that UV filtering materials wear down over time)
- Keep materials on exhibit for as little time as possible
- Keep a record of the length of exhibit and the exposure to light over time, if you are able!

What are the recommended environmental guidelines?

For lighting exhibits:

generally accepted recommendations limited visible light levels for light-sensitive materials, including paper, to 55 lux (5 foot-candles), and for less sensitive materials to a maximum of 165 lux (15 foot-candles).

Colby, Karen M. "Suggested Exhibition/Exposure Policy for Works of Art on Paper." July 1993. Available at The Lighting Resource web site: <http://www.webcom.com/~lightsrc/>

Otherwise:

choose lighting guidelines that make sense for you

What are the recommended environmental guidelines?

- Different research into different types of materials has led to an overlapping, potentially confusing array of recommendations
- An environment that you can reasonably maintain in a stable manner is the goal, so let that guide you more than any set recommendation.
- Effects don't average out – that is, if you had a climate that was great half the time and lousy the other half the degradation of the materials doesn't proceed as if your environmental conditions were middling – they proceed more like they've been exposed constantly to the terrible conditions.

What are the recommended guidelines?

- Most important – maintain RH within +/- 5% or less over a 24 hour period if you are able, with as little seasonal variation as possible and definitely less than 15% variation overall. (National Park Service Conserve-o-Gram).
- Pick a temperature that will help you do this.
- Think about where you are storing collections materials! Avoid the attic and the basement! Don't place things directly above heating registers.

So, what's the good news?

- Here's an area in which you can use the understanding climate control that you gain to make decisions that will positively impact the longevity of your collection
- You quite likely can make positive changes to your environment
- If you can't make big changes, you can still make small ones

Where to start

- Start by gaining as complete an understanding as you can of the conditions that affect your collections – this means beginning an environmental monitoring program of some sort.

So how do you measure environmental Conditions. And what, exactly, are you measuring?



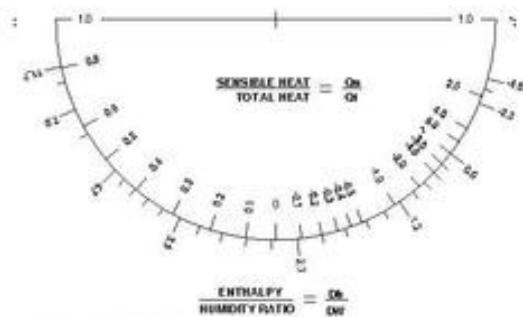
We looked at the effects of temperature and relative humidity on collections materials, but what are they, how do they relate to one another and how do you change them?

Psychrometrics

- root Psychr = cold
- describes the relationship between temperature, relative humidity and a number of other climatic factors

What is relative humidity?

- How much water air at a given temperature is holding, versus how much it can hold before it begins to condense out. (sort of)

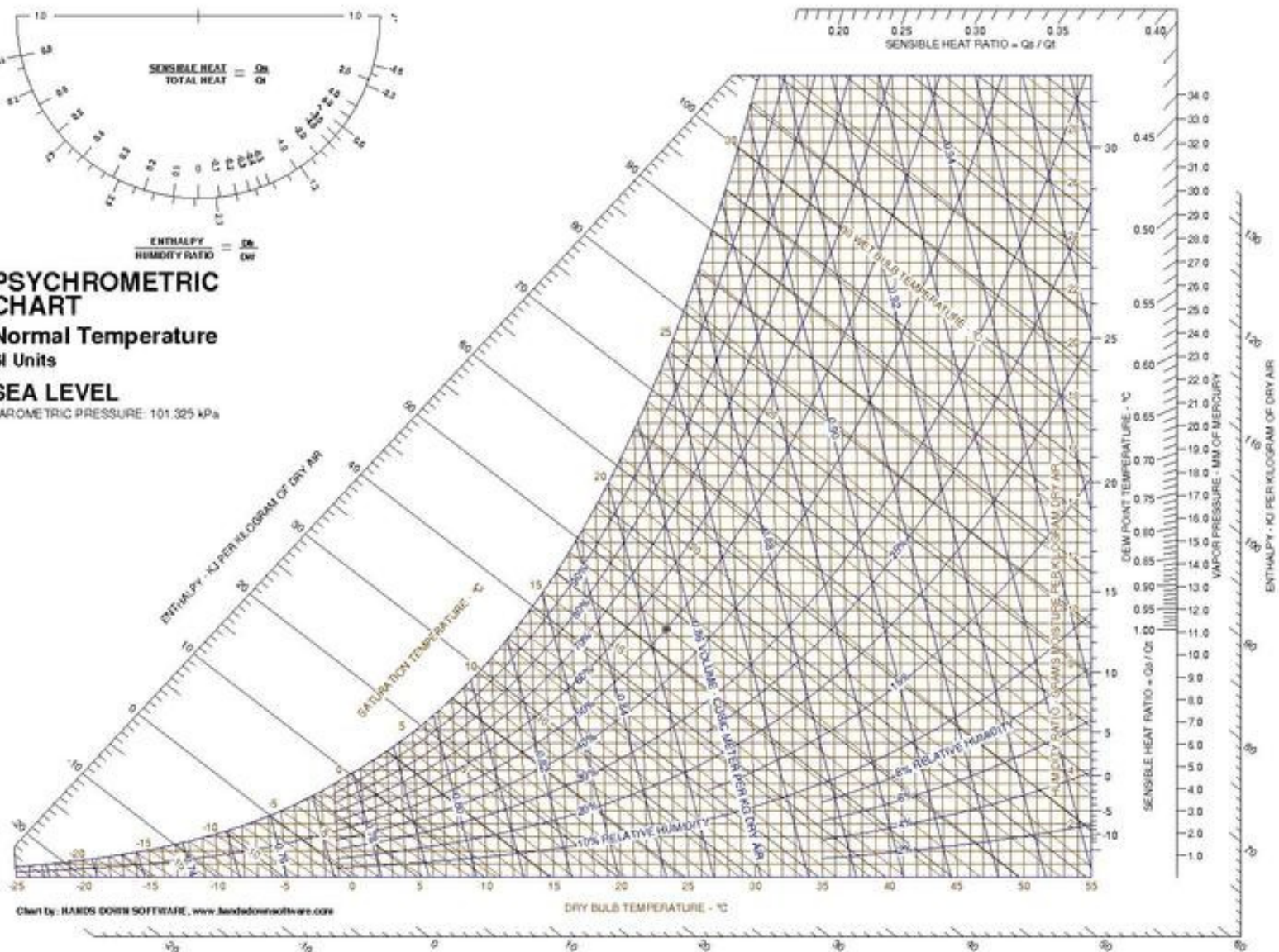


PSYCHROMETRIC CHART

**Normal Temperature
SI Units**

SEA LEVEL

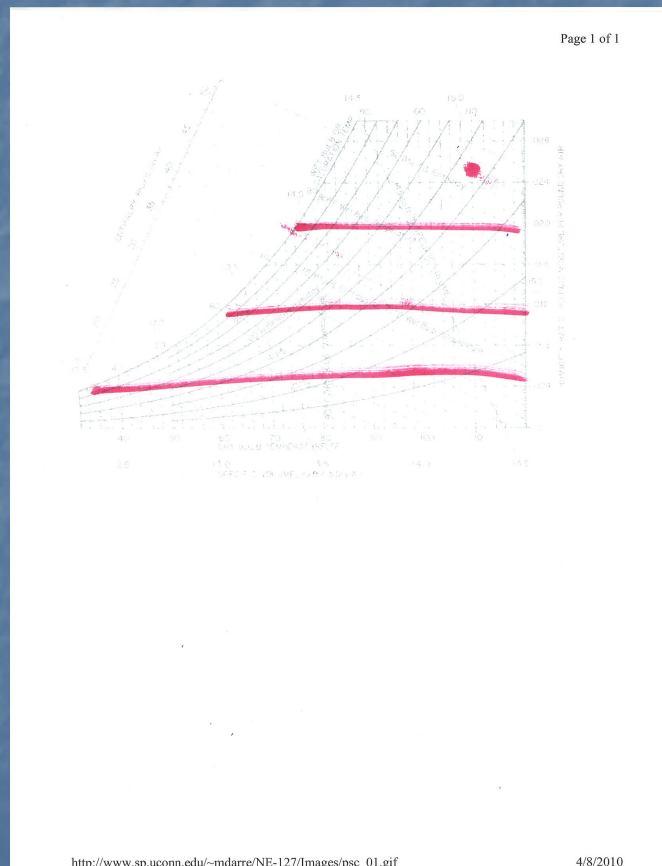
BAROMETRIC PRESSURE: 101.325 kPa



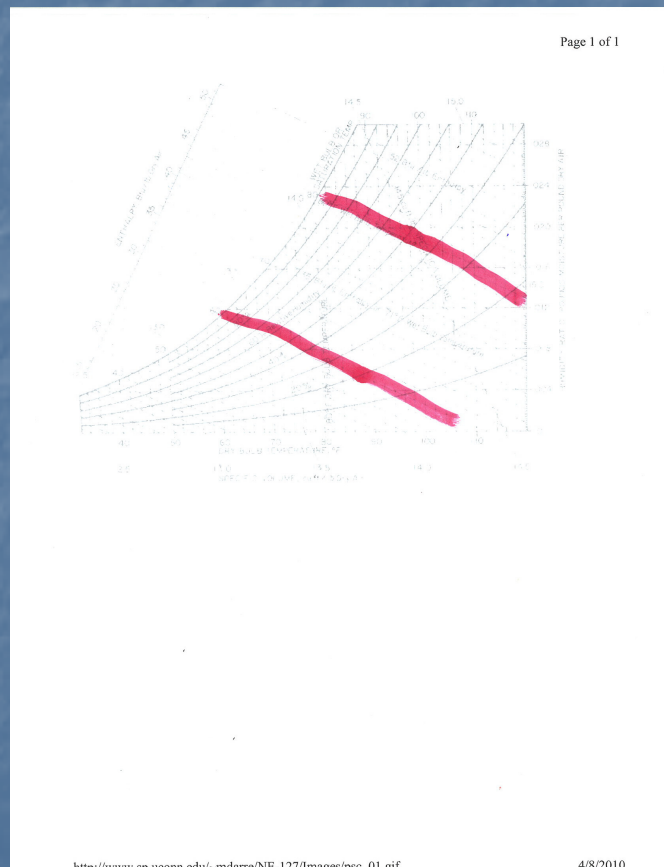
Dry Bulb and Wet Bulb

- Dry Bulb Temperature - The temperature measured by an ordinary thermometer.
- • Wet Bulb Temperature - The lowest temperature to which an air mixture can be cooled solely by the addition of water.

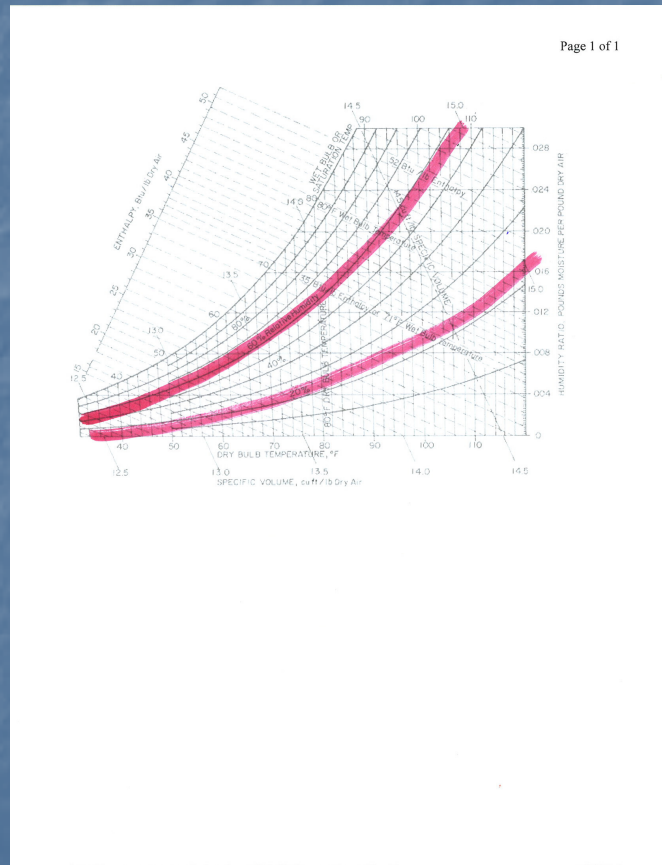
Dry Bulb



Wet Bulb



Relative Humidity



Using your psychrometric chart...

...find the relative humidity for a 65°F wet bulb temperature and 75°F dry bulb temperature

Dew Point and Condensation

- Cautionary tale of the shall-remain-nameless museum
- Ramifications for introducing a humidification system

What you need to know about Air Conditioning

- There are often heating components as part of an air conditioning cycle – air is conditioned by heating and then cooling.
- Potential for humidity control
- Talk to your facilities people

New Systems

- If you ever have the chance to install a new HVAC system in a building, or to participate in the building of a new museum, library or archives, you have options for including both humidification and dehumidification systems
- A good resource is: William P. Lull

Special Controls for Exhibit Cases

- Fiber optic lights do not produce UV or IR light, and the heat source is outside the case.
- Use of sorbant materials to maintain good humidity levels

Sorbants

- Silica and other sorbants (e.g. Artsorb)



silica designed for commercial use



silica developed specifically for museum applications

- ✓ Look at manufacturers instructions to calculate the quantity needed and how to recondition
 - ✓ Assume one complete air exchange per day for most cases in making calculations
-
- Resource: "Demystifying Silica Gel" by Steven Weintraub
http://www.apsnyc.com/pdf/silica_gel_SW_2003.pdf

Finally, Measuring Conditions



Why Monitor

- Spot checks are useful
- Spot checks aren't always sufficient; continuous monitoring over the course of a year is best to examine the extremes affecting your collection.
- Recorded data helps prove to TPTB that your conditions aren't what they should be.
- Check the effects of modification you make to your systems

Types of equipment you may encounter -

These types of equipment are good for spot checks only

Digital (or analog) hygrometer
(or thermohygrometer)



Psychrometer (sling or fan driven)

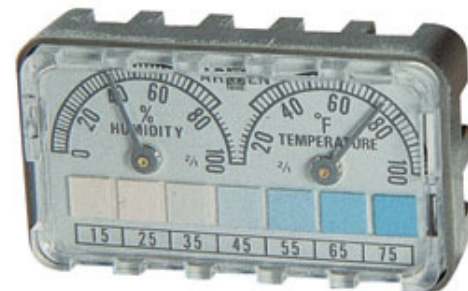
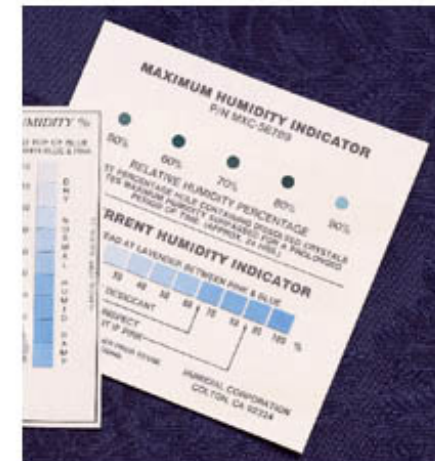


Types of equipment you may encounter -

Good for spot checks

Indicator cards

small thermohygrometer



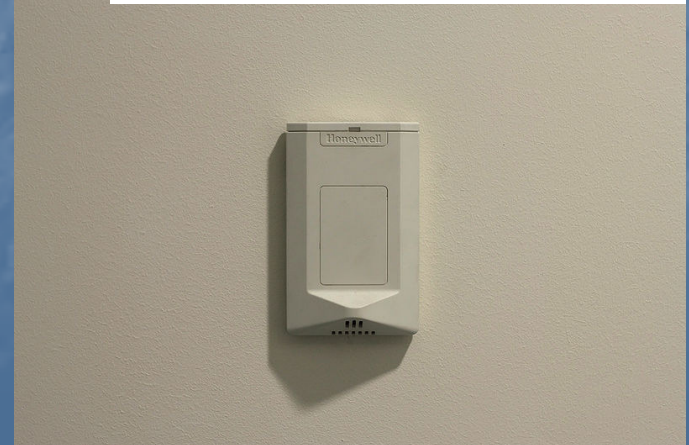
Types of monitoring equipment you may encounter

Record continuous data

Hygrothermograph



Data logger



Datalogger output

records center Feb 10 [Compatibility Mode] - Microsoft Excel

Date/Time																
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Date/Time	Temperat RH (%)	c:1	Intensity (lum/sqf)	c:3											
2	02/02/10 1	70.39	24.9	2	Serial NurSeries: Temperature (*F)	c:1										
3	02/02/10 1	70.39	24.9	2	Serial NurSeries: RH (%)	c:1	2									
4	02/02/10 1	70.39	24.9	2	Serial NurSeries: Intensity (lum/sqf)	c:3										
5	02/02/10 1	70.39	24.9	2												
6	02/02/10 1	70.39	24.9	2	Series	Temperature (*F)	c:1									
7	02/02/10 1	70.39	24.9	2	Logger Inf	Information specific to the logger										
8	02/02/10 1	70.39	24.9	2	Model	HOBO TEMP, RH, LI, EXT (C) 1996 ONSET										
9	02/02/10 2	70.39	24.9	2	Serial Nur	561849										
10	02/02/10 2	70.39	24.9	2	Memory	58192										
11	02/02/10 2	70.39	24.9	2	Extra Info	Information used by tech support										
12	02/02/10 2	70.39	24.9	2	Model Nu	8										
13	02/02/10 2	70.39	24.9	2	Version	N 4										
14	02/02/10 2	70.39	24.9	2	Deployme	19										
15	02/02/10 2	69.71	25	2	Series Inf	Information about the data in the series										
16	02/02/10 2	69.71	25	2	Points Use	2576										
17	02/02/10 2	69.71	25	2	First Point	02/02/10 18:13:35.0										
18	02/02/10 2	69.71	25	2	Last Point	03/03/10 08:53:35.0										
19	02/02/10 2	69.71	25	2	Duration	28 Days 14:40:00.0										
20	02/02/10 2	69.02	25	2	Stats	Calculated from the series										
21	02/02/10 2	69.02	25	2	Wrap Cou	0										
22	02/02/10 2	69.02	25	2	Max Value	71.77										
23	02/02/10 2	69.02	25	2	Min Value	64.22										
24	02/03/10 0	69.02	25.4	2	Avg Value	69.68										
25	02/03/10 0	69.02	25.4	2	Launch Pa	Mirrors the launch dialog settings										
26	02/03/10 0	69.02	25.4	2	Descriptio	records center										
27	02/03/10 0	68.33	25.5	2	Wrap	Off										
28	02/03/10 0	68.33	25.5	2	Interval	00:16:00.0										
29	02/03/10 0	68.33	25.5	2	Delay Star	02/02/10 18:13:35										
30	02/03/10 0	68.33	25.5	2	Channel I	[On/Off] Sensor [Part Number]										
31	02/03/10 0	68.33	25.5	2	Channel I	On/Off Temperature										

records center Feb 10

Ready

Start Hobo Data Microsoft Excel - reco... Search Desktop 1:58 PM

What to choose?

Factors include

- your budget
- what extremes must be measured
- Can be affected by the purpose for which your measuring – i.e. do you need to record continuously or can you start with spot checks?
- How much room for error do you have?

Calibrate equipment!

Using your psychrometer...

...Find the Temperature and Relative Humidity of
this room

How to make improvements, on the cheap

- Keep winter heating low
- Seal windows
- Keep outside doors and windows closed
- Block radiant heat from heaters
- Keep controls at same levels, even if building is unoccupied.
- Re-think how you're using space
- Improve building seals

From NEDCC Preservation Leaflet # 2.6 Low Cost/No Cost Improvements in Climate Control, based on the work of William P Lull (Garrison/Lull Inc, Princeton Junction, NJ).

http://nedcc.org/resources/leaflets/2The_Environment/06LowCostNoCost.php

Mid-cost improvements

- Use of portable air conditioning units
- Use of portable humidifiers or de-humidifiers
- Improve insulation

If you can make major improvements

- Look for professional help who have experience in designing and moderating climates in libraries, museums and archives.

Caution

- Make sure the improvements you're making in one area aren't affecting other environmental conditions adversely. Keep monitoring.

New directions in passive climate control

- Buffering effect of collection itself
- Buffering effect of building materials

Sources of Assistance - Funding

- Conservation Assessment Program (IMLS)
\$5000 for Conservation Assessment of Building and Environment
<http://www.heritagepreservation.org/CAP/index.html>
postmark deadline of December 1, 2010 (Grant Applications are made available around Labor Day)
- Shrab Mini Grants
\$1500 (mandatory \$500 match) for Conservation Assessment of Building and Environment
www.shrab.in.gov
deadline May 14, 2010
- Preservation Assistance for Smaller Institutions (NEH)
>\$6000 for Assessments, Supplies, Equipment, Training or to address a specific preservation problem
<http://www.neh.gov/grants/guidelines/pag.html>
Deadline May 18, 2010
- Foundation Grants
Find nearly 2,000 more grants of \$5000 or more awarded by 500 organization for preservation and conservation activities in public, academic, research, school, and special libraries, as well as archives and museums
<http://www.loc.gov/preserv/foundtn-grants.html>

Also keep an eye on

- National Park Service Grants: <http://www.nps.gov/history/grants.htm>
- National Endowment for the Arts Grants: <http://www.nea.gov/grants/>
- National Endowment for the Humanities Grants: <http://www.neh.gov/grants/>

Sources of Further Information

- CoOL (Conservation Online) – Environmental Topics
<http://cool.conservation-us.org/bytopic/environment/>
- Colby, Karen M. "Suggested Exhibition/Exposure Policy for Works of Art on Paper." July 1993. Available at The Lighting Resource web site:
<http://www.webcom.com/~lightsrc/>
- William P. Lull, any writings
- Nedcc.org
- Conserve o grams - http://www.nps.gov/museum/publications/conservation/cons_toc.html
- Cci notes - <http://www.cci-icc.gc.ca/crc/notes/index-eng.aspx>
- Dr. Timothy Padfield - <http://www.conservationphysics.org/>
- Sebera, Isoperms - <http://www.clir.org/pubs/reports/isoperm/isoperm.html>
- Image permanence institute -
http://www.imagepermanenceinstitute.org/shtml_sub/dl_prescalc.asp
- Tagged Bookmarks: www.delicious.com/katie_mullen